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(54) **MIRROR DRIVE DEVICE, AND IMAGE PICKUP APPARATUS EQUIPPED WITH MIRROR DRIVE DEVICE**

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(57) **ABSTRACT**

A mirror drive device that hardly causes a delay of drive of a second mirror with respect to control for a first mirror and enables stable drive. A first holding member holds a first mirror. A supporting member rotatably supports the first holding member. A second holding member holds a second mirror and is rotatably supported by the first holding member. A drive member is rotatably supported by the supporting member and is rotatably connected with the second holding member. Rotation of one of the first holding member and the second holding member interlocks with rotation of the other through rotation of the drive member.

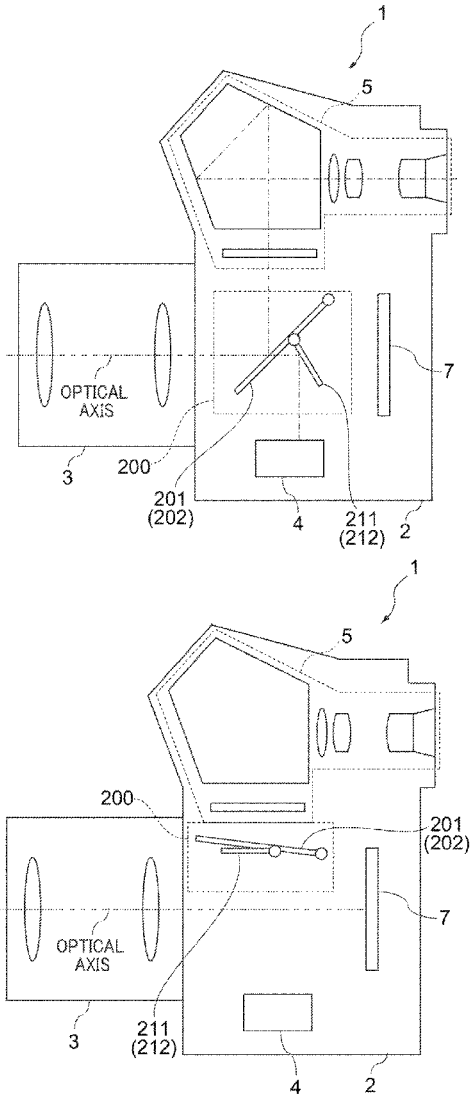
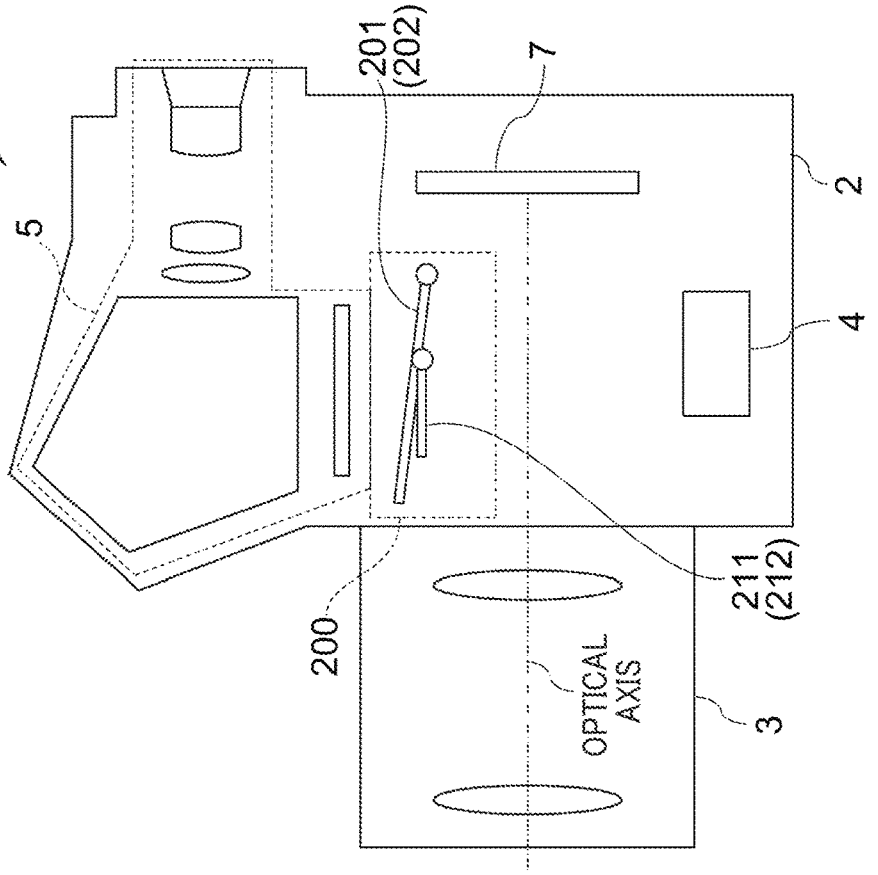


FIG. 1B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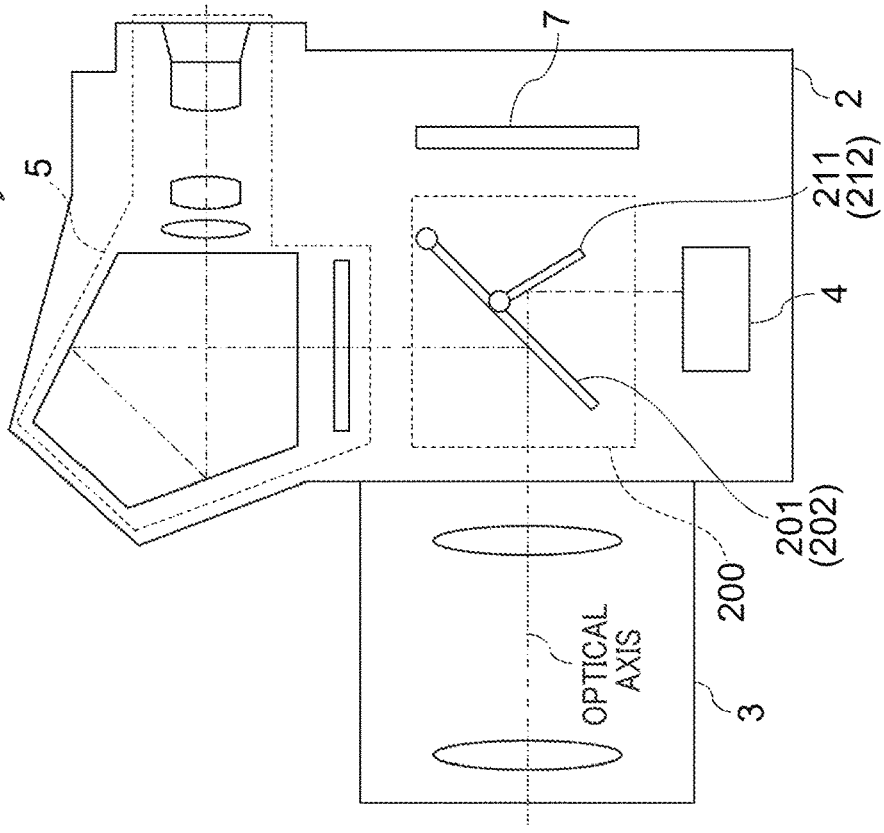
5
201
(202)
7
2
4
211
(212)
200
OPTICAL
AXIS
3

FIG. 1A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4
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(202)
200
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AXIS
3

FIG. 2B

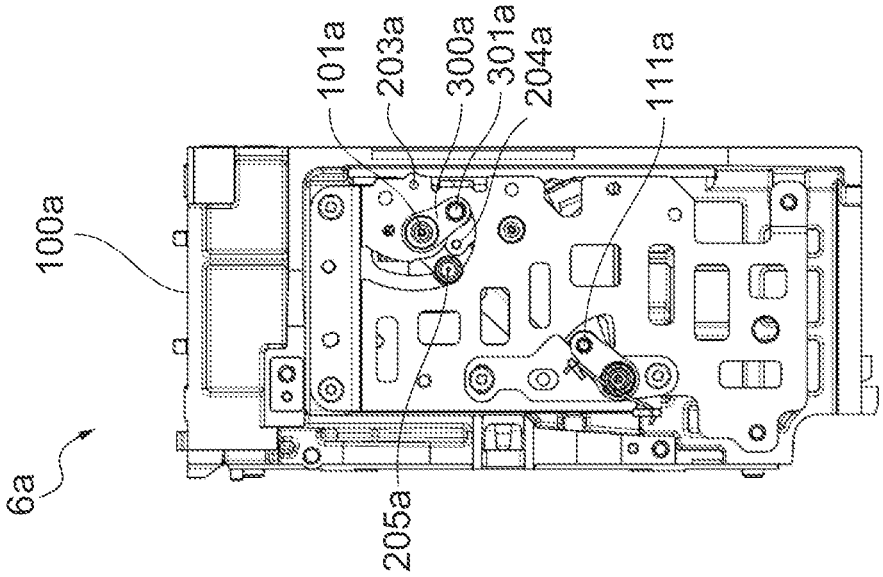
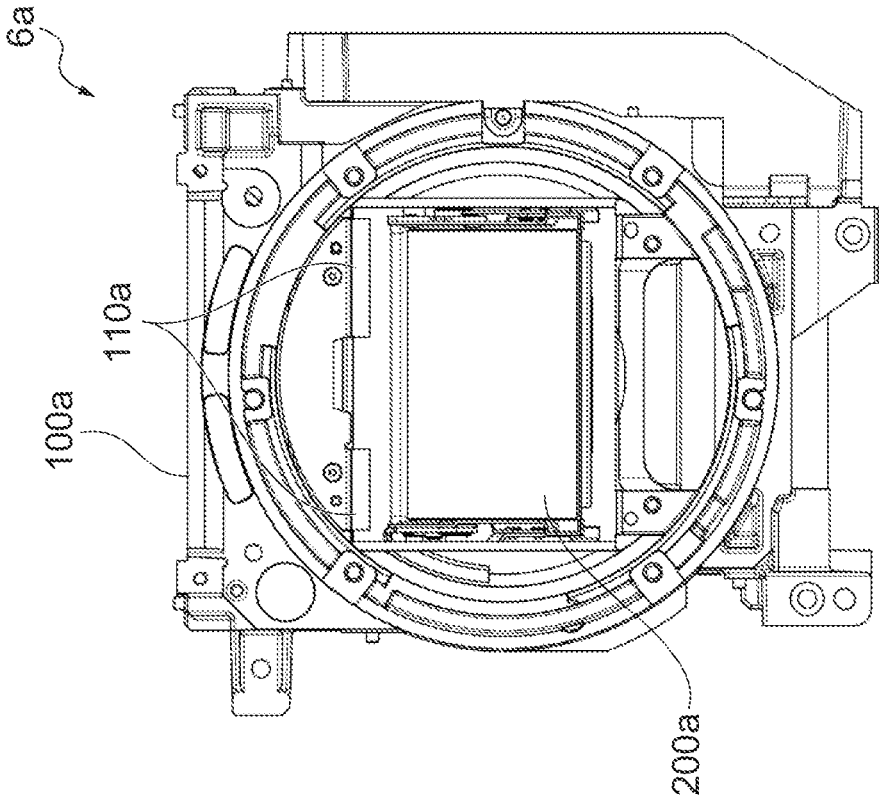
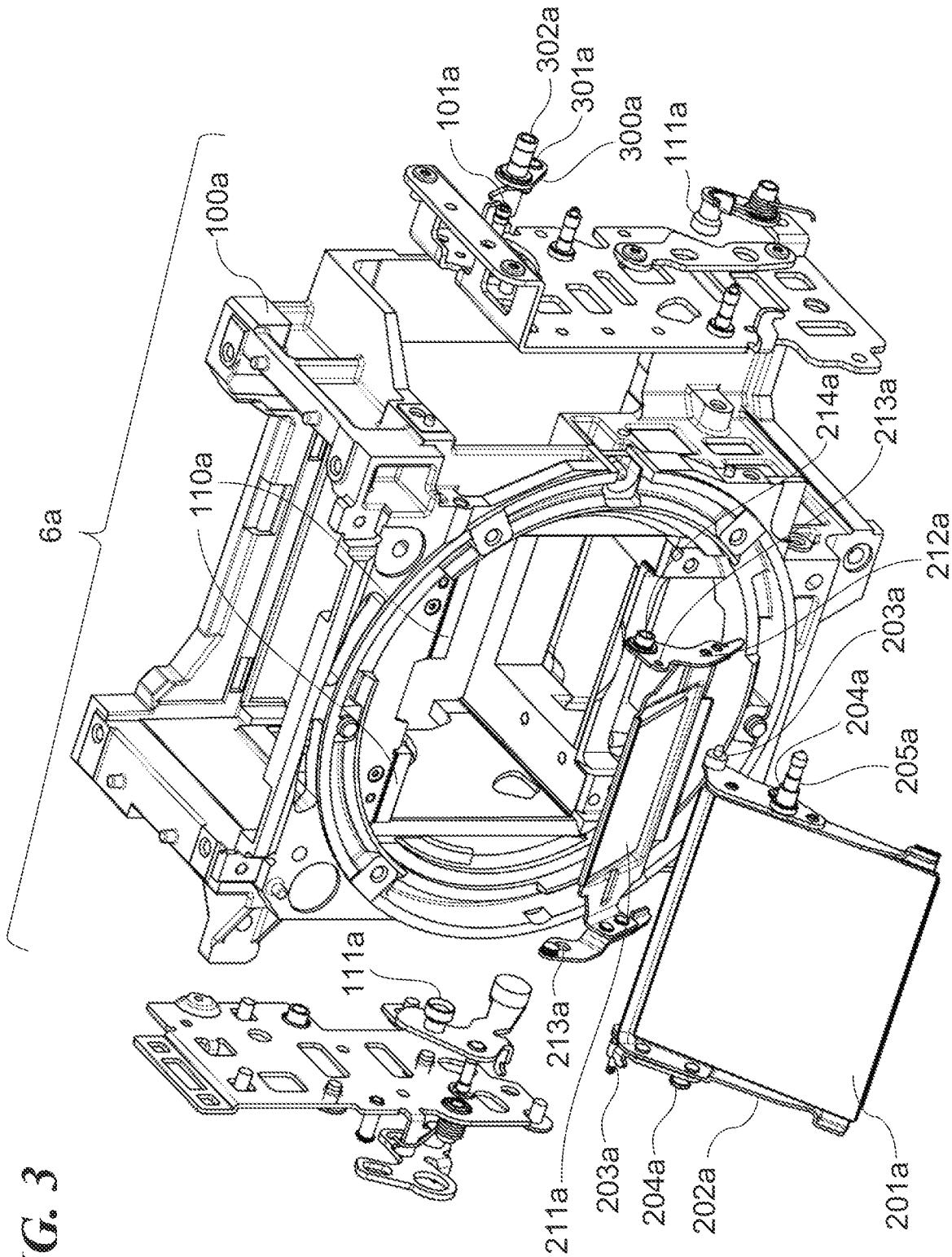


FIG. 2A

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100a
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101a
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301a
300a
111a
214a
213a
212a
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204a
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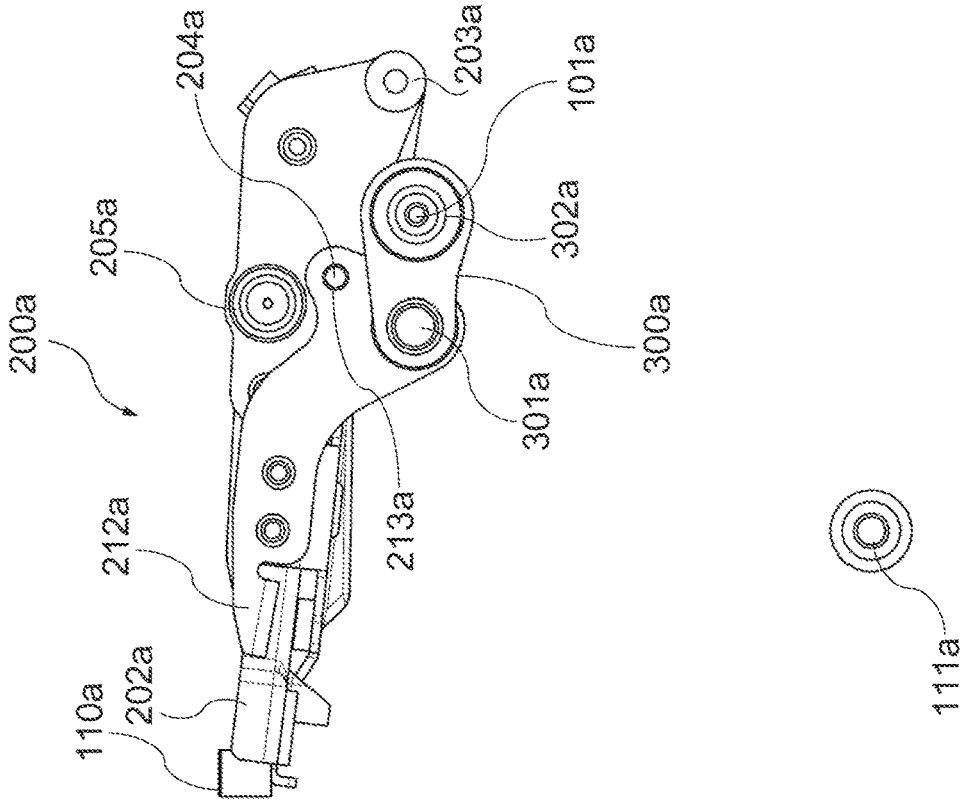
111a
213a
211a
203a
204a
202a
201a

FIG. 3

FIG. 4B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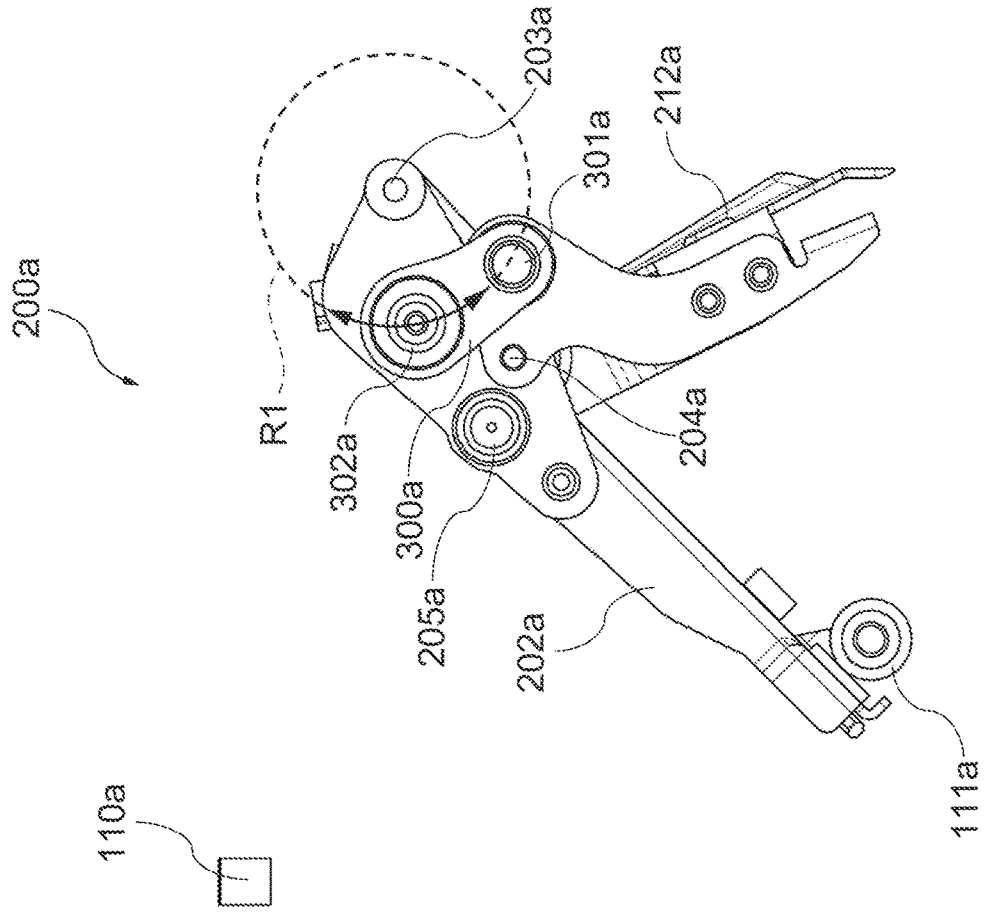
212a
110a
202a
111a

FIG. 4A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212a
R1
302a
204a
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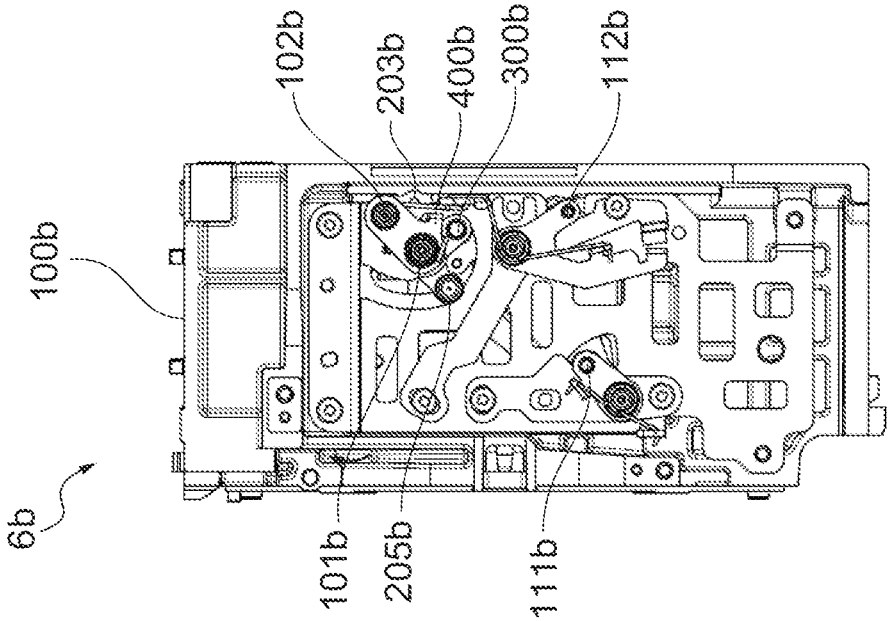
205a
202a
110a
111a

FIG. 5B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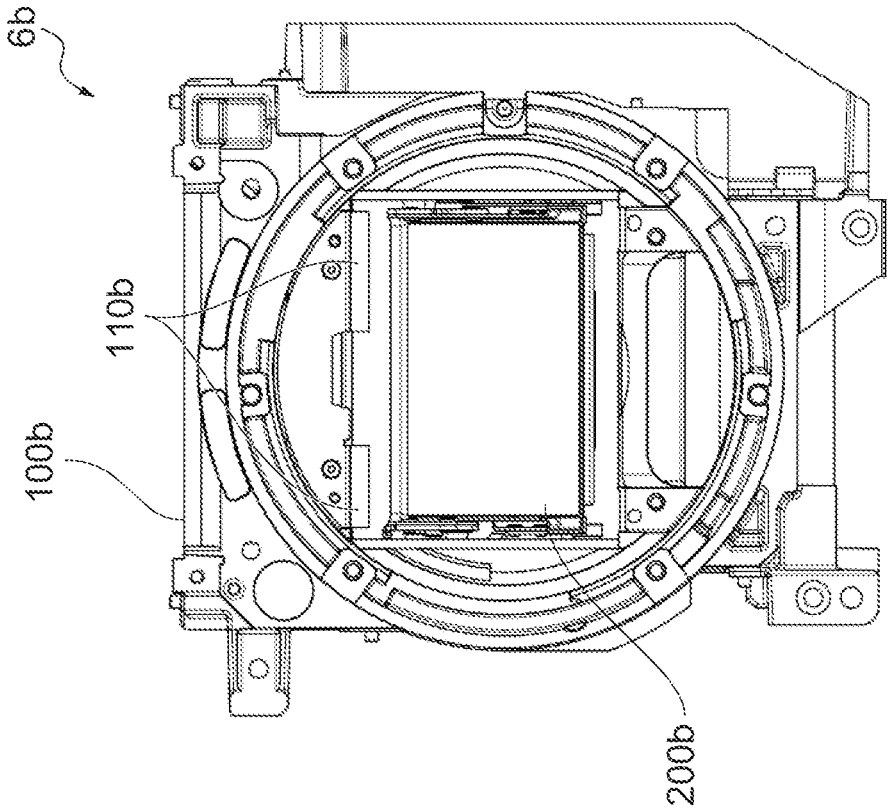
111b

FIG. 5A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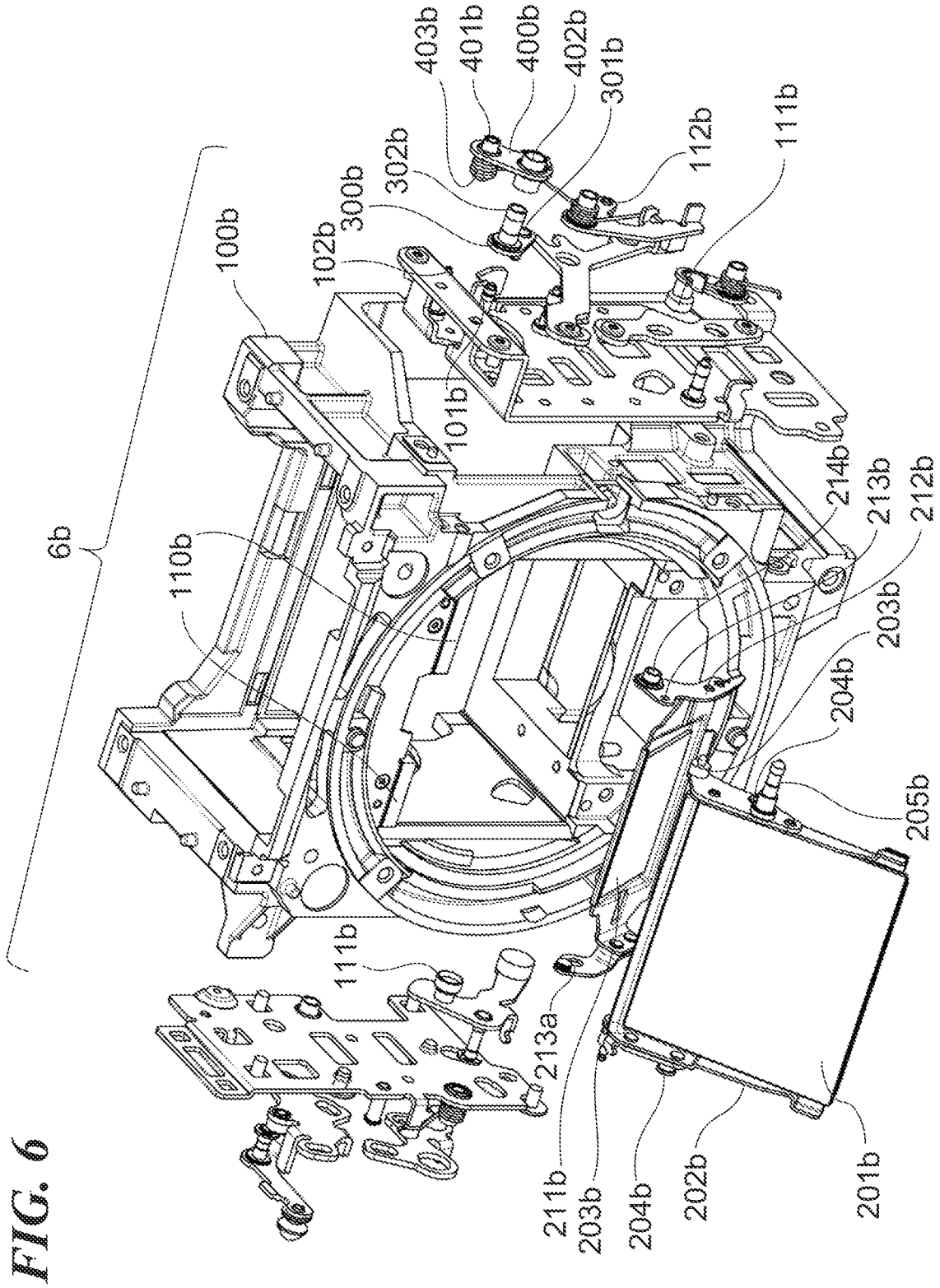
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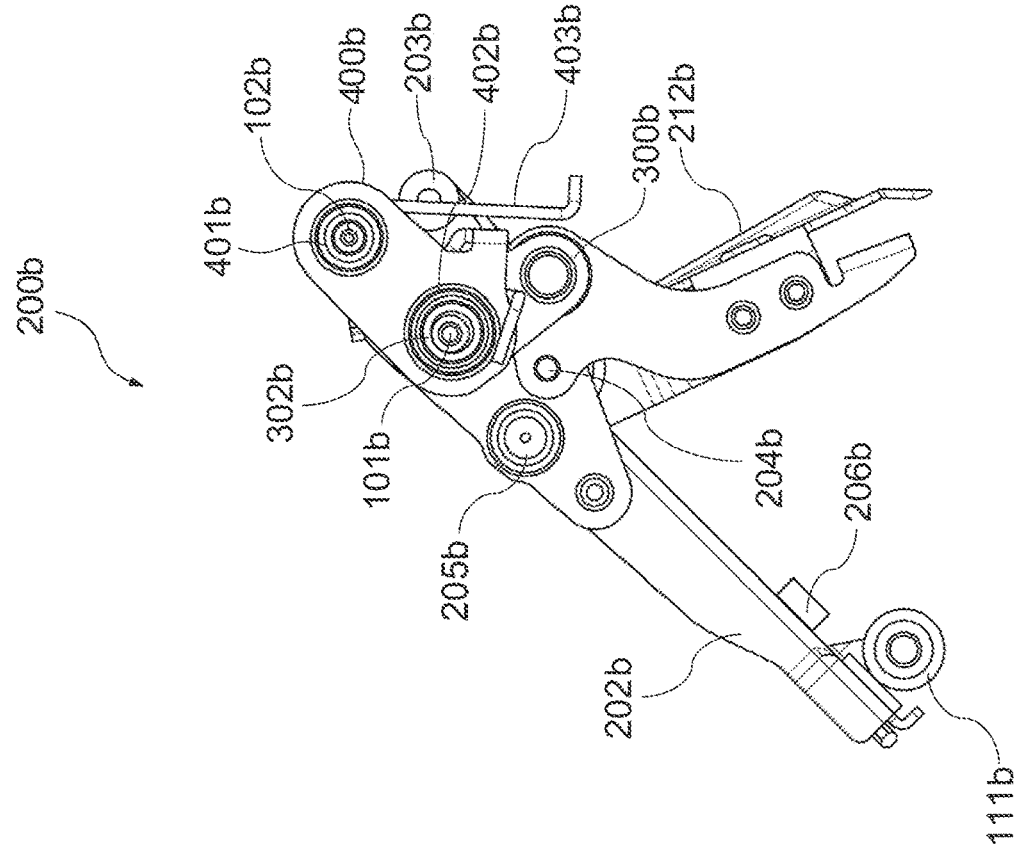
402b
301b
112b
111b
101b
214b
213b
212b
203b
204b
205b
110b
111b
213a
211b
203b
204b
202b
201b

FIG. 6

FIG. 7B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401b
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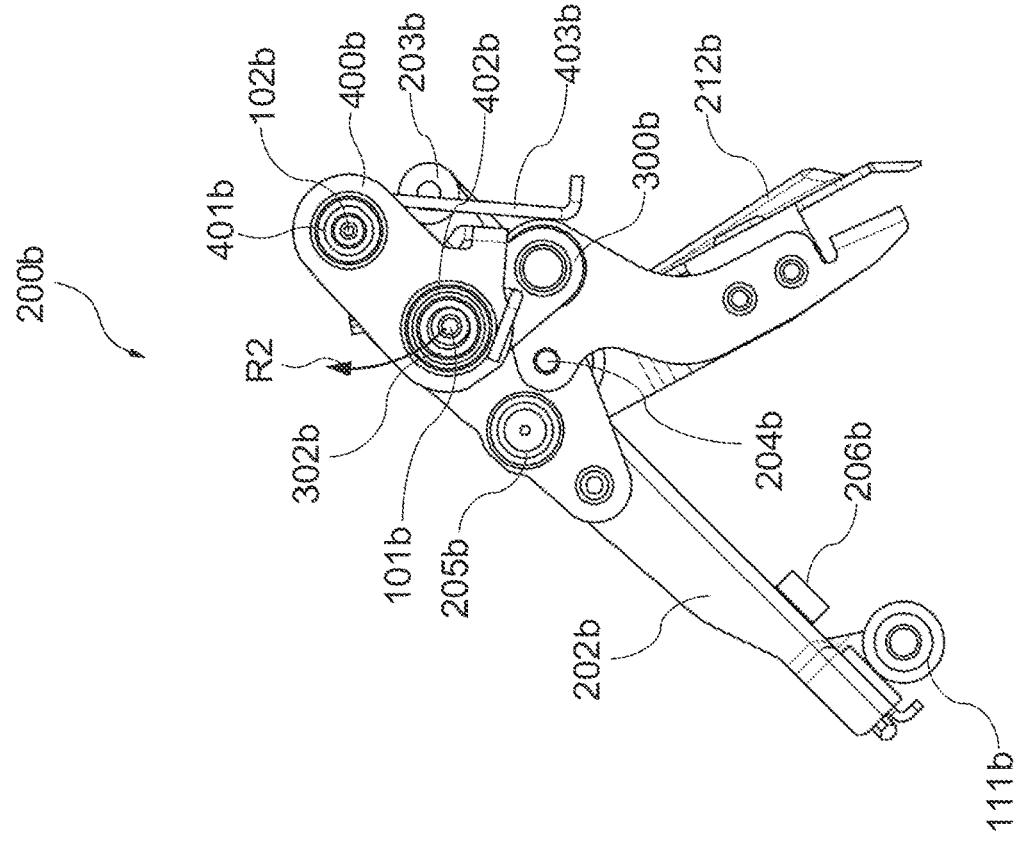
300b
212b
302b
101b
205b
204b
206b
202b
111b

FIG. 7A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102b
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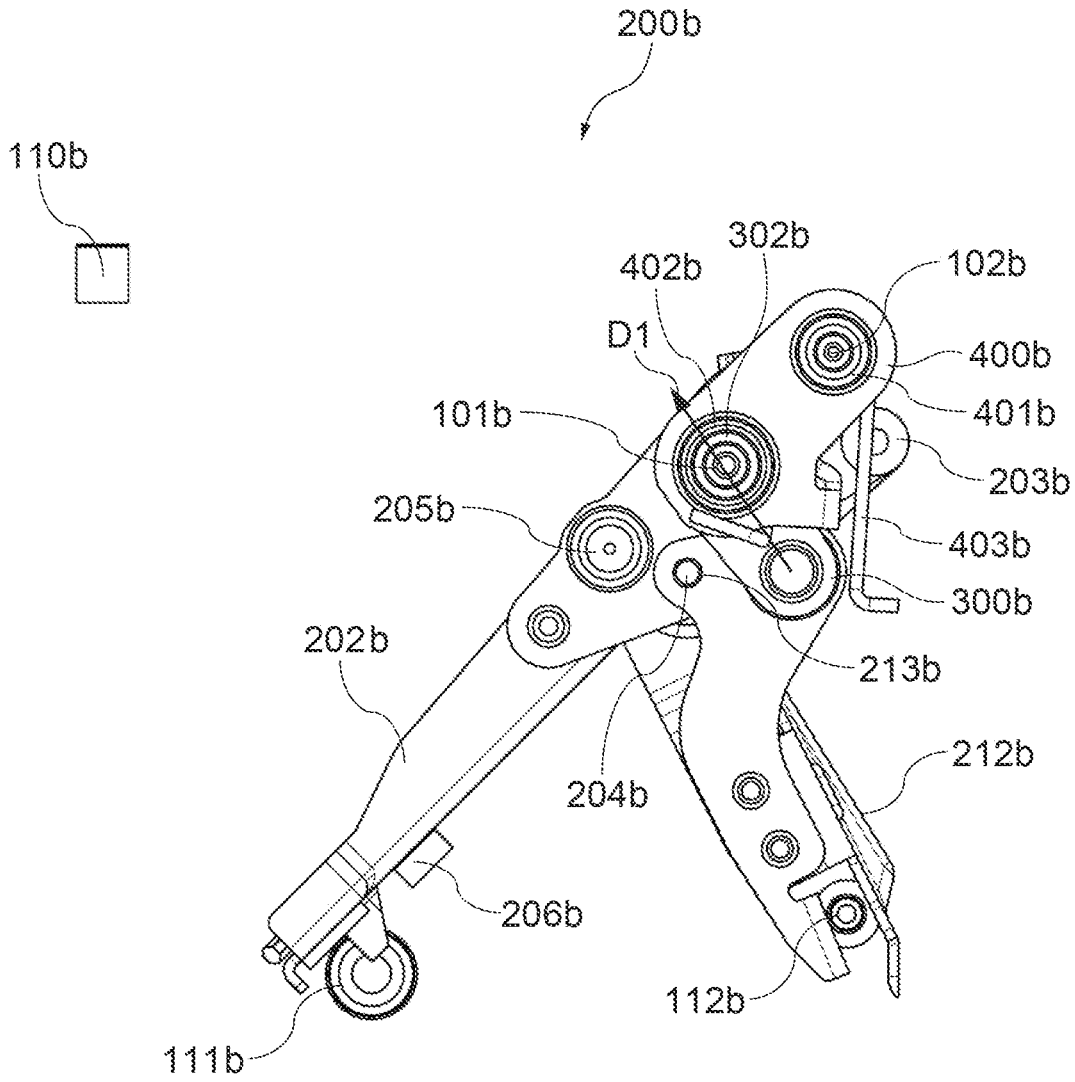
202b
111b

FIG. 8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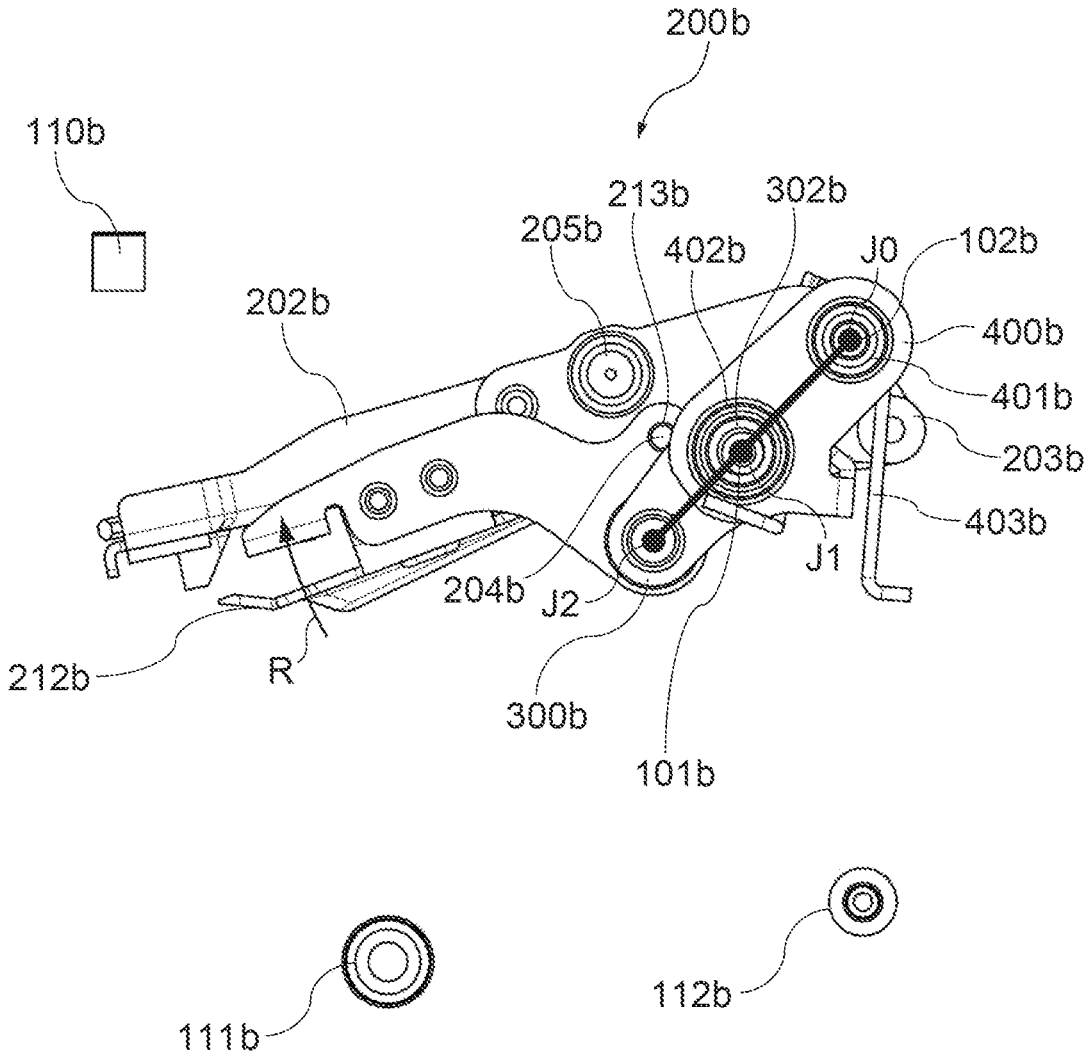
402b
102b
D1
400b
101b
401b
203b
205b
403b
300b
202b
213b
212b
204b
206b
112b
111b

FIG. 9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J0
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403b
J1
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J2
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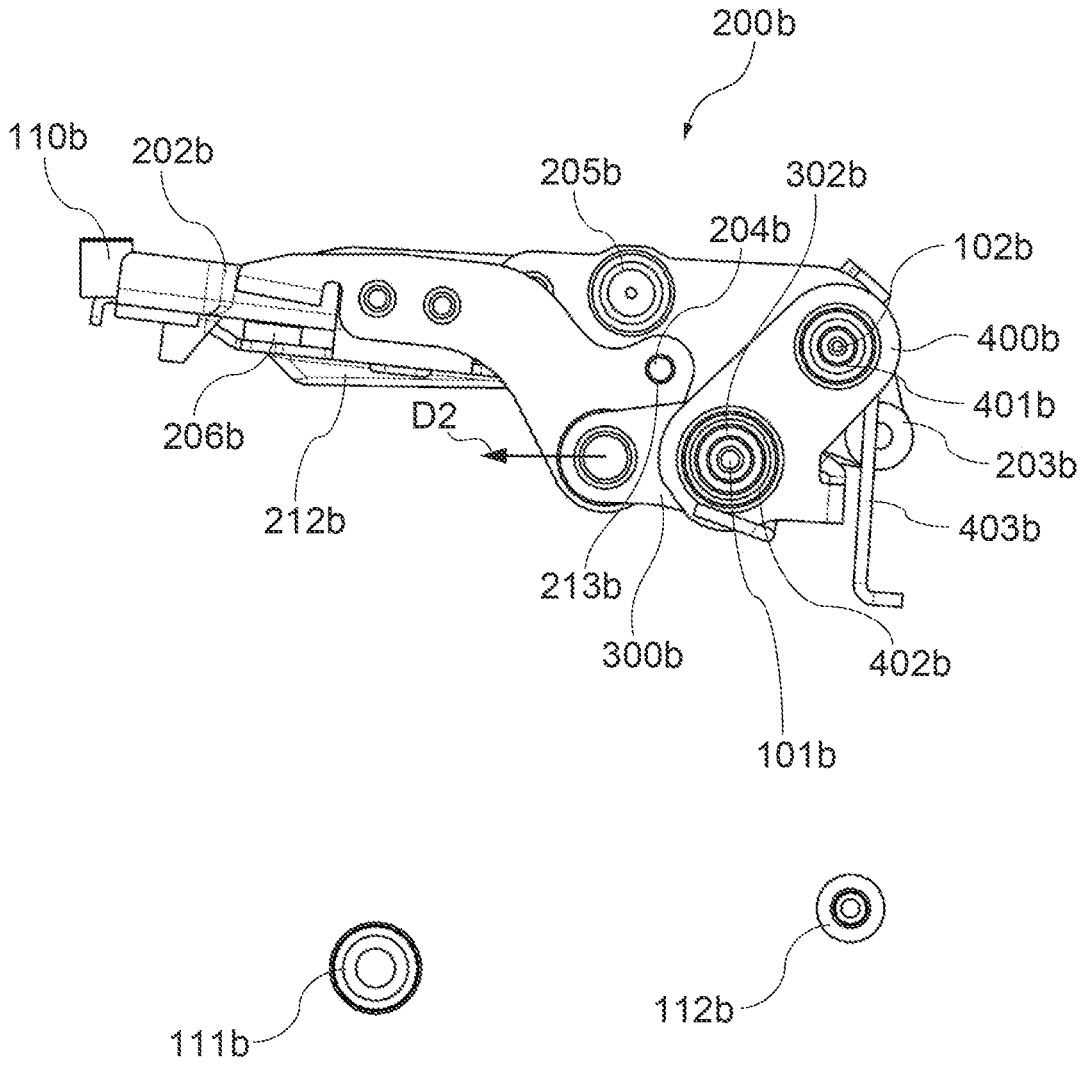
R
300b
101b
111b
112b

FIG. 10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402b
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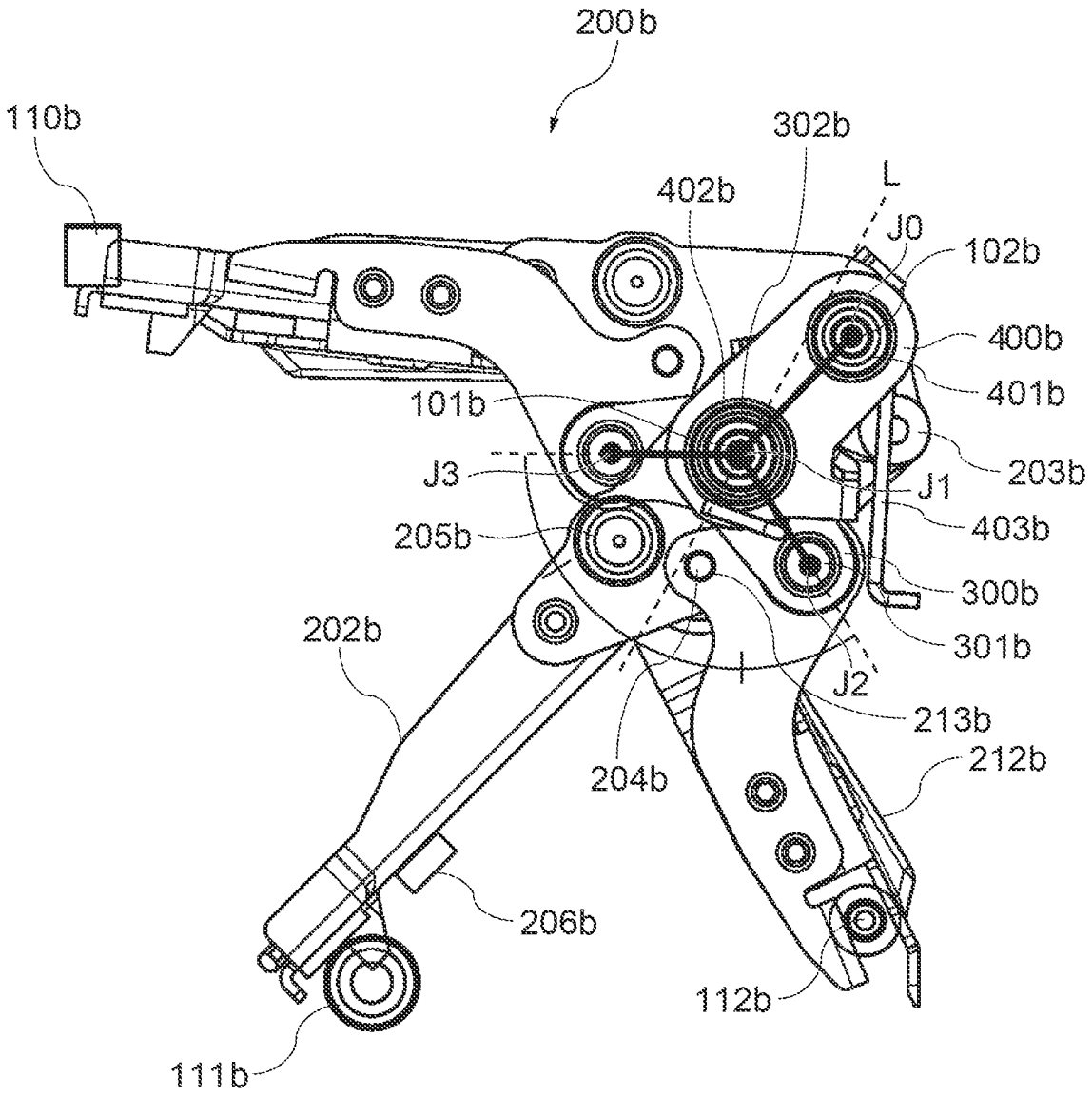
112b

FIG. 11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302b
L
402b
J0
102b
400b
401b
101b
J3
J1
203b
205b
403b
300b
202b
301b
J2
213b
204b
212b
206b
112b
111b

MIRROR DRIVE DEVICE, AND IMAGE PICKUP APPARATUS EQUIPPED WITH MIRROR DRIVE DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a mirror drive device and an image pickup apparatus equipped with the mirror drive device.

Description of the Related Art

[0002] Some of single-lens reflex cameras are provided with a mirror drive device that has a main mirror that reflects an incident light beam toward a finder optical system and a sub mirror that guides a part of the incident light beam that is transmitted through the main mirror to a focus detection device. The mirrors stop at respective predetermined positions that obstruct a photographing light path by contacting stoppers provided in a mirror box in a camera body before photographing so as to guide the incident light beam to the finder optical system and the focus detection device. In the meantime, a mirror driving mechanism retracts the mirrors outside the photographing light path (a mirror-up action) at a time of photographing and returns the mirrors to the predetermined positions in the photographing light path (a mirror-down action) after photographing.

[0003] Such a mirror driving mechanism is required to reduce a bound (hereinafter referred to as a "mirror bound") that occurs when the mirrors collide with the respective stoppers at the time of the mirror-down action. This is because reduction of the bound of the main mirror stabilizes a finder image promptly and reduction of the bound of the sub mirror enables rapid start of the focus detection. Moreover, shortening of a period from occurrence of the mirror bound to convergence is able to improve a continuous photographing speed.

[0004] In order to solve such a problem, Japanese Patent No. 6160312 discloses a mirror drive device that is equipped with an interlocking lever that interlocks a sub mirror with a main mirror. A bound of the sub mirror is reduced by restricting rotation of the interlocking lever using a damping member that rotates by interlocking with a main-mirror holder.

[0005] However, the technique disclosed in the above-mentioned patent causes a delay of the drive of the sub mirror to the control for main mirror because a connection part of the interlocking lever with a sub-mirror holder is a long hole. As a result, the mirror bound occurs when the sub mirror collides with the stopper in the mirror-down action to return the mirrors into the photographing light path. Moreover, since energization force of a spring that energizes the interlocking lever has to be decreased after being increased once during a series of the mirror-up action and the mirror-down action, load fluctuation becomes large and the drive is not stabilized.

SUMMARY OF THE INVENTION

[0006] The present invention provides a mirror drive device that hardly causes a delay of drive of a second mirror (sub mirror) with respect to control for a first mirror (main mirror) and enables stable drive.

[0007] Accordingly, a first aspect of the present invention provides a mirror drive device including a first holding member that holds a first mirror, a supporting member that rotatably supports the first holding member, a second holding member that holds a second mirror and is rotatably supported by the first holding member, and a drive member that is rotatably supported by the supporting member and is rotatably connected with the second holding member. Rotation of one of the first holding member and the second holding member interlocks with rotation of the other through rotation of the drive member.

[0008] Accordingly, a second aspect of the present invention provides a mirror drive device including a first holding member that holds a first mirror, a supporting member that rotatably supports the first holding member, a second holding member that holds a second mirror and is rotatably supported by the first holding member, an energization member that is rotatably supported by the support member, a drive member that is rotatably connected to the energization member and is rotatably connected with the second holding member, and a restriction part that is provided in the support member and restricts a rotatable range of the energization member. The energization member is energized in one of two rotatable directions. Rotation of one of the first holding member and the second holding member interlocks with rotation of the other through rotation of the drive member.

[0009] Accordingly, a third aspect of the present invention provides an image pickup apparatus including a focus detection sensor, an optical finder, a mirror unit that is provided with a first mirror that reflects a light beam entered through a photographing optical system to the optical finder and a second mirror that reflects a light beam transmitted through the first mirror toward the focus detection sensor, and the mirror drive device according to the first aspect.

[0010] Accordingly, a fourth aspect of the present invention provides an image pickup apparatus including a focus detection sensor, an optical finder, a mirror unit that is provided with a first mirror that reflects a light beam entered through a photographing optical system to the optical finder and a second mirror that reflects a light beam transmitted through the first mirror toward the focus detection sensor, and the mirror drive device according to the second aspect.

[0011] The present invention achieves the mirror drive device that hardly causes a delay of the drive of the second mirror with respect to the control for the first mirror and that enables stable drive.

[0012] Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1**A and FIG. **1**B are sectional views showing a schematic configuration of an image pickup apparatus according to embodiments of the present invention.

[0014] FIG. **2**A and FIG. **2**B are respectively a front view and a right side view showing a mirror drive device according to a first embodiment.

[0015] FIG. **3** is an exploded perspective view showing the mirror drive device according to the first embodiment.

[0016] FIG. **4**A and FIG. **4**B are side views for describing a configuration of a mirror unit in the first embodiment.

[0017] FIG. **5**A and FIG. **5**B are respectively a front view and a right side views showing a mirror drive device according to a second embodiment.

[0018] FIG. **6** is an exploded perspective view showing the mirror drive device according to the second embodiment.

[0019] FIG. **7**A and FIG. **7**B are side views for describing a rotatable range of a sub-mirror holder in the second embodiment.

[0020] FIG. **8** is a right side view showing a mirror-down state of a mirror unit in the second embodiment.

[0021] FIG. **9** is a right side view showing a state during transition of the mirror unit from a mirror-down position to a minor-up position in the second embodiment.

[0022] FIG. **10** is a right side view showing the mirror-up state of the mirror unit in the second embodiment.

[0023] FIG. **11** is a right side view showing the mirror-down state and mirror-up state of the mirror unit in the second embodiment in an overlapped fashion.

DESCRIPTION OF THE EMBODIMENTS

[0024] Hereafter, embodiments according to the present invention will be described in detail by referring to the drawings. First, an entire configuration that is common to image pickup apparatuses according to first and second embodiments mentioned later will be described by referring to FIG. **1**A and FIG. **1**B.

[0025] FIG. **1**A is a sectional view showing a schematic configuration of the image pickup apparatus **1** according to the embodiment of the present invention and shows a state where a main mirror (first mirror) **201** and a sub mirror (second mirror) **211** are in mirror-down positions. FIG. **1**B is a sectional view showing the schematic configuration of the image pickup apparatus **1** and shows a state where the main mirror **201** and the sub mirror **211** are in mirror-up positions.

[0026] Specifically, the image pickup apparatus **1** is a digital single lens reflex camera, and has a camera body **2** and an interchangeable lens (lens barrel) **3** that is detachable to the camera body **2**. The camera body **2** is provided with a focus detection unit **4**, an optical finder unit **5**, a mirror unit **200**, and an image sensor **7**.

[0027] The mirror unit **200** is one of components of a mirror drive device. The mirror unit **200** has the main mirror **201** and a main-mirror holder (first holding member) **202** that holds the main mirror **201**. Moreover, the mirror unit **200** has a sub mirror **211** and a sub-mirror holder (second holding member) **212** that holds the sub mirror **211**.

[0028] The main mirror **201** employs a half minor. The main-mirror holder **202** and sub-mirror holder **212** are rotatably attached to a minor box (support member) that is not shown. A mirror driving mechanism (not shown) rotates the main mirror **201** (main-mirror holder **202**) between a mirror-down position (first position) in FIG. **1**A and a minor-up position (second position) in FIG. **1**B. In connection with the rotation of the main-minor holder **202**, the sub mirror **211** (sub-minor holder **212**) is rotated between a mirror-down position (third position) and a minor-up position (position of a fourth).

[0029] The state where both the main mirror **201** and sub mirror **211** are in the mirror-down positions as shown in FIG. **1**A will be described as "the minor unit **200** is in a mirror-down state" in the following description. When the mirror unit **200** is in the mirror-down state, the main mirror **201** and sub mirror **211** are held at predetermined positions in a photographing light path. In this state, an incident light beam passing through the interchangeable lens **3** is divided by the main mirror **201**. A part of the incident light beam that is reflected by the main mirror **201** is guided to a pentagonal prism of the optical finder unit **5**. In the meantime, the light beam transmitted through the main mirror **201** is guided to the sub mirror **211**, and then reflected by the sub mirror **211** toward the focus detection unit **4**. Accordingly, when the mirror unit **200** is in the mirror-down position, the incident light beam which passed the interchangeable lens **3** is not guided to the image sensor **7**.

[0030] The state where both the main mirror **201** and sub mirror **211** are in the mirror-up positions as shown in FIG. **1**B will be described as "the mirror unit **200** is in a mirror-up state" in the following description. When the mirror unit **200** is in the mirror-up state, the main mirror **201** and sub mirror **211** are retracted from the photographing light path (above the photographing light path). At this time, the main-mirror holder **202** and sub-minor holder **212** move upward in an overlapped state. In this state, the incident light beam passing through the interchangeable lens **3** is guided to the image sensor **7** and forms an image on the image sensor **7** without being guided to the optical finder unit **5** and the focus detection unit **4**.

[0031] The mirror drive device moves the mirror unit **200** between the mirror-down state and mirror-up state in this way. When the main mirror **201** and sub mirror **211** are in the mirror-down positions, respectively, the main-minor holder **202** and sub-mirror holder **212** are also in the mirror-down positions. Moreover, when the main mirror **201** and sub mirror **211** are in the mirror-up positions, respectively, the main-minor holder **202** and sub-mirror holder **212** are also in the mirror-up positions. Then, the mirror drive device does not directly drive the main mirror **201** and sub mirror **211** but rotates the main mirror **201** and sub mirror **211** by driving the main-mirror holder **202** and sub-mirror holder **212**. Accordingly, a rotation and position of each mirror will be described using a drive and position of each mirror holder suitably in the following description.

[0032] FIG. **2**A is a front view showing a schematic configuration of a mirror drive device **6***a* according to a first embodiment. FIG. **2**B is a right side view showing the schematic configuration of the mirror drive device **6***a*. It should be noted that the right side of the mirror drive device **6***a* is defined when the mirror drive device **6***a* is viewed from the front (the right side in FIG. **2**A). FIG. **3** is an exploded perspective view showing the schematic configuration of the mirror drive device **6***a*.

[0033] It should be noted that a reference numeral that is configured to add 'a' to a reference numeral applied to a component of the mirror drive device described by referring to FIG. **1**A and FIG. **1**B shall be applied to the corresponding component in the first embodiment. For example, a mirror unit, main mirror, and sub mirror are respectively denoted by reference numerals **200***a*, **201***a* and **211***a*. It should be noted that the mirror drive device **6***a* provides mechanisms that drive the mirror unit **200***a* at both of left and right sides of the mirror box **100***a* as shown in FIG. **3**. Since the mechanisms have almost the same configuration, the right side mechanism is mainly described.

[0034] The mirror drive device **6***a* is provided with a mirror box **100***a*, mirror unit **200***a* and sub-minor drive member **300***a*. The mirror unit **200***a* is provided with the

main mirror **201***a* a main-minor holder **202***a*, the sub minor **211***a* and a sub-mirror holder **212***a*. The main mirror **201***a* is held by the main-mirror holder **202***a*, and the sub mirror **211***a* is held by the sub-mirror holder **212***a*.

[0035] The main-minor holder **202***a* has a main-mirror rotation shaft **203***a*, sub-mirror supporting shaft **204***a*, and main-mirror drive shaft **205***a*. The main-mirror holder **202***a* is rotatably supported by the mirror box **100***a* with the main-mirror rotation shaft **203***a* so as to be rotatable between the mirror-down position and mirror-up position around the main-mirror rotation shaft **203***a* as a rotation center. The sub-mirror holder **212***a* has a sub-minor rotation hole **213***a* and sub-mirror drive hole **214***a*. The sub-mirror holder **212***a* is rotatably supported by the main-minor holder **202***a* by fitting the sub-minor supporting shaft **204***a* of the main-minor holder **202***a* into the sub-mirror rotation hole **213***a*.

[0036] The sub-mirror drive member **300***a* has a sub-minor drive shaft **301***a* and connecting sleeve **302***a*. The sub-minor drive member **300***a* is rotatably supported by the mirror box **100***a* by fitting a shaft **101***a* formed on the mirror box **100***a* into the connecting sleeve **302***a*. Moreover, the sub-mirror drive member **300***a* is rotatably connected with the sub-mirror holder **212***a* by fitting the sub-mirror drive shaft **301***a* into the sub-mirror drive hole **214***a*.

[0037] Hereinafter, the configuration of the mirror drive device **6***a* will be further described by referring to FIG. **4**A and FIG. **4**B in addition to FIG. **2**A, FIG. **2**B, and FIG. **3**. FIG. **4**A is a right side view when the mirror unit **200***a* is in the mirror-down state. FIG. **4**B is a right side view when the mirror unit **200***a* is in the mirror-up state.

[0038] A main-mirror drive mechanism (not shown) is arranged at the right side of the mirror box **100***a* when the mirror box **100***a* is viewed from the front. The main-mirror drive mechanism is able to employ a well-known mechanism (including a mirror drive lever unit and motor unit) that is disclosed in Japanese Laid-Open Patent Publication (Kokai) No. 2017-40828 (JP 2017-40828A), for example.

[0039] When the mirror unit **200***a* is in the mirror-down state, the main-mirror holder **202***a* is energized by the main-minor drive mechanism in the mirror-down direction around the main-mirror rotation shaft **203***a*. Main-minor stoppers **111***a* are provided in the right and left of the mirror box **100***a*. The main-minor holder **202***a* is held at the mirror-down position because the main-mirror holder **202***a* is energized in the minor-down direction and contacts the main-mirror stoppers **111***a*. In the meantime, the position of the sub-minor holder **212***a* is decided by the sub-mirror supporting shaft **204***a* of the main-mirror holder **202***a* and the sub-minor drive shaft **301***a* of the sub-minor drive member **300***a*. Accordingly, when the main mirror **201***a* is at the mirror-down position, the sub mirror **211***a* is also held at the mirror-down position.

[0040] When the mirror unit **200***a* is in the minor-up state, the main-mirror holder **202***a* is energized by the main-minor drive mechanism in the minor-up direction around the main-mirror rotation shaft **203***a*. Main-minor stoppers **110***a* are provided in the mirror box **100***a*. The main-minor holder **202***a* is held at the mirror-up position because the main-minor holder **202***a* is energized in the mirror-up direction and contacts the main-minor stoppers **110***a*. The position of the sub-minor holder **212***a* is decided by the sub-mirror supporting shaft **204***a* of the main-mirror holder **202***a* and the sub-minor drive shaft **301***a* of the sub-mirror drive member **300***a*. Thus, when the main mirror **201***a* is at the minor-up position, the sub mirror **211***a* is also held at the mirror-up position.

[0041] In this way, the mirror drive device **6***a* is configured so that rotation of one of the main-minor holder **202***a* and sub-minor holder **212***a* interlocks with rotation of the other through the sub-mirror drive member **300***a*. In the mirror drive device **6***a*, transition of the mirror unit **200***a* between the mirror-down state (FIG. **4**A) and the minor-up state (FIG. **4**B) occurs because the main-minor drive mechanism elevates and lowers the main-mirror drive shaft **205***a* of the main-mirror holder **202***a*. The drive of the main-mirror holder **202***a* is controlled by using the mechanism disclosed in Japanese Laid-Open Patent Publication (Kokai) No. 2017-40828 (JP 2017-40828A) mentioned above as the main-mirror drive mechanism.

[0042] In the mirror unit **200***a*, since the position of the sub-minor holder **212***a* is decided by the sub-mirror supporting shaft **204***a* and sub-minor drive shaft **301***a* the drive of the sub-mirror holder **212** is controlled without delay from the drive controlling of the main-minor holder **202***a*. That is, the mirror bound of the sub-minor holder **212***a* is reduced by optimizing the drive control so that the mirror bound will not occur when the main-mirror holder **202***a* stops at the mirror-down position.

[0043] In order to guide the incident light beam to the optical finder unit **5** correctly, it is necessary to adjust the positions of the main-mirror stoppers **111***a* in general so as to adjust the angle of the main mirror **201***a* with respect to the optical axis at the mirror-down position. The mirror drive device **6***a* is configured so that the shaft **101***a* that fits into the connecting sleeve **302***a* of the sub-minor drive member **300***a* is fixed to the mirror box **100***a*. Accordingly, when the mirror-down position of the main-mirror holder **202***a* is decided, the mirror-down position of the sub-mirror holder **212***a* is also decided by the sub-mirror drive member **300***a*. Accordingly, the angle of the sub mirror **211***a* at the mirror-down position may vary according to the adjustment result of the main mirror **201***a*. In such a case, the position and posture of the focus detection unit **4** should be adjusted according to the angle of the sub mirror **211***a* at the mirror-down position.

[0044] As compared with this, if the focus detection unit **4** is not adjustable, the shaft **101***a* should be a different part from the mirror box **100***a* and the position of the shaft **101***a* should be adjustable. This enables angle adjustment of the sub mirror **211***a*. In that case, the position of the shaft **101***a* is preferably adjustable along a circular arc R**1** around the main-mirror rotation shaft **203***a* shown by a broken line in FIG. **4**A. This reduces an influence on the main-mirror drive mechanism because a length relation of a link mechanism that consists of the main-mirror holder **202***a*, sub-mirror holder **212***a*, and sub-mirror drive member **300***a* does not vary even if the position of the shaft **101***a* is adjusted.

[0045] FIG. **5**A is a front view showing a schematic configuration of a mirror drive device **6***b* according to a second embodiment. FIG. **5**B is a right side view showing the schematic configuration of the mirror drive device **6***b*. FIG. **6** is an exploded perspective view showing the schematic configuration of the mirror drive device **6***b*. FIG. **7**A and FIG. **7**B are views for describing a rotatable range of a sub-mirror holder **212***b* at the mirror-down position. It should be noted that a reference numeral that is configured to add 'b' to a reference numeral applied to a component of

the mirror drive device described by referring to FIG. **1**A and FIG. **1**B shall be applied to the corresponding component in the second embodiment. For example, a mirror unit, main mirror, and sub mirror are respectively denoted by reference numerals **200***b*, **201***b*, and **211***b*. It should be noted that the mirror drive device **6***b* provides mechanisms that drive the mirror unit **200***b* at both of left and right sides of the mirror box **100***b* as shown in FIG. **6**. Since the mechanisms have almost the same configuration, the right side mechanism is mainly described.

[0046] The mirror drive device **6***b* is provided with a mirror box **100***b*, mirror unit **200***b*, sub-mirror drive member **300***b*, and sub-mirror energization member **400***b*. The mirror unit **200***b* is provided with the main minor **201***b*, a main-minor holder **202***b*, the sub mirror **211***b*, and a sub-minor holder **212***b*. The main mirror **201***b* is held by the main-mirror holder **202***b*, and the sub mirror **211***b* is held by the sub-mirror holder **212***b*.

[0047] The main-mirror holder **202***b* has a main-mirror rotation shaft **203***b*, sub-mirror supporting shaft **204***b*, and main-minor drive shaft **205***b*. The main-minor holder **202***b* is rotatably supported by the mirror box **100***b* with the main-minor rotation shaft **203***b* so as to be rotatable between the mirror-down position and minor-up position around the main-minor rotation shaft **203***b* as a rotation center. The sub-minor holder **212***b* has a sub-mirror rotation hole **213***b* and sub-mirror drive hole **214***b*. The sub-minor holder **212***b* is rotatably supported by the main-minor holder **202***b* by fitting the sub-mirror supporting shaft **204***b* of the main-mirror holder **202***b* into the sub-minor rotation hole **213***b*.

[0048] The sub-mirror energization member **400***b* has a supporting hole **401***b*, an energization sleeve **402***b*, and a sub-mirror energization spring **403***b*. The sub-mirror energization member **400***b* is rotatably supported by the mirror box **100***b* by fitting a shaft **102***b* of the mirror box **100***b* into the supporting hole **401***b*. The sub-mirror energization spring **403***b* has a coil section. The coil section is fitted around a cylindrical pipe constituting the supporting hole **401***b* of the sub-minor energization member **400***b*. In such a state, one end of the sub-mirror energization spring **403***b* is hooked on the energization sleeve **402***b* and the other end is hooked on the mirror box **100***b*. The sub-minor energization spring **403***b* energizes the sub-mirror energization member **400***b* in a direction indicated by an arrow R**2** shown in FIG. **7**A around the supporting hole **401***b*. The arrow R**2** direction is the mirror-up direction that is one of the two directions (the minor-up direction and mirror-down direction) in which the sub-minor holder **212***b* rotates.

[0049] The sub-mirror drive member **300***b* has a sub-mirror drive shaft **301***b* and a connecting sleeve (a first cylindrical portion) **302***b*. A restriction part (shaft) **101***b* formed in the mirror box **100***b* is inserted into the connecting sleeve **302***b*. Moreover, the connecting sleeve **302***b* is slidably fitted into the energization sleeve (a second cylindrical portion) **402***b* of the sub-mirror energization member **400***b*. Thereby, the sub-minor drive member **300***b* is connected to the sub-mirror energization member **400***b* so as to be rotatable around the energization sleeve **402***b*. The sub-mirror drive member **300***b* is rotatably connected with the sub-minor holder **212***b* by fitting the sub-minor drive shaft **301***b* into the sub-mirror drive hole **214***b*.

[0050] There is a predetermined backlash (gap) between the inner periphery of the connecting sleeve **302***b* of the sub-mirror drive member **300***b* and the outer periphery of the restriction part **101***b* of the mirror box **100***b*. The rotatable range of the sub-mirror energization member **400***b* around the supporting hole **401***b* is restricted within the limits of the backlash. The sub-mirror holder **212***b* is movable independently from the main-minor holder **202***b* within the angular range between the states in FIG. **7**A and FIG. **7**B.

[0051] More specifically, FIG. **7**A shows the state where the sub-mirror energization member **400***b* rotates in the arrow R**2** direction and where the connecting sleeve **302***b* contacts the restriction part **101***b*. In the meantime, FIG. **7**B shows the state where the sub-mirror energization member **400***b* rotates in the direction opposite to the arrow R**2** direction and where the connecting sleeve **302***b* contacts the restriction part **101***b*.

[0052] The sub-mirror energization spring **403***b* has a function to cause transition of the mirror unit **200***b* from the state in FIG. **7**B to the state in FIG. **7**A by energizing the sub-mirror energization member **400***b* in the arrow R**2** direction. That is, the sub-mirror energization spring **403***b* plays a role that energizes the sub-mirror holder **212***b* in the mirror-down direction through the sub-mirror energization member **400***b* when the sub-mirror holder **212***b* is at the mirror-down position. The mirror box **100***b* has a sub-mirror stopper **112***b*. The sub-mirror holder **212***b* is energized by the sub-mirror energization spring **403***b* in the mirror-down direction and the angle of the sub mirror **211***b* with respect to the optical axis is decided in the state where the sub-minor holder **212***b* contacts the sub-mirror stopper **112***b*. Accordingly, the angle of the sub-mirror holder **212***b* (sub mirror **211***b*) is adjustable independently from the angle of the main-mirror holder **202***b* (main minor **201***b*) by adjusting the position of the sub-mirror stopper **112***b* in the mirror box **100***b*.

[0053] A main-mirror drive mechanism (not shown) is provided at the right side of the mirror box **100***b*. A well-known mechanism can be used for the main-minor drive mechanism in the second embodiment as with the first embodiment. As with the mirror drive device **6***a*, the mirror drive device **6***b* is configured so that rotation of one of the main-minor holder **202***b* and sub-mirror holder **212***b* interlocks with rotation of the other through the sub-mirror drive member **300***b*. Transition of the mirror unit **200***a* between the mirror-down state and the mirror-up state occurs because the main-mirror drive mechanism elevates and lowers the main-mirror drive shaft **205***b* of the main-mirror holder **202***b*.

[0054] Next, actions of the mirror drive device **6***b* will be described in detail. FIG. **8** is a right side view showing the mirror unit **200***b* in the mirror-down state. The main-mirror holder **202***b* is energized by a main-mirror drive mechanism (not shown) in the mirror-down direction (counterclockwise in FIG. **8**) and is held at the mirror-down position by contacting the main-mirror stopper **111***b*. The sub-mirror holder **212***b* receives force in a direction of an arrow D**1** direction from the sub-mirror drive member **300***b* that is pulled up by the sub-mirror energization member **400***b*. The sub-mirror holder **212***b* is energized in the mirror-down direction (counterclockwise in FIG. **8**) around the sub-mirror rotation hole **213***b* and is held at the mirror-down position by contacting the sub-mirror stopper **111***b*. At this time, the connecting sleeve **302***b* of the sub-mirror drive member **300***b* is not in contact with the restriction part bib of the mirror box **100***b*.

[0055] FIG. **9** is a right side view showing a state during transition of the mirror unit **200***b* from the mirror-down position to the minor-up position. A point J**0** in FIG. **9** is a point to which the center line of the shaft **102***b* (the center line of the rotation of the sub-mirror energization member **400***b* to the mirror box **100***b*) is projected to a plane that intersects perpendicularly with the center line. A point J**1** is a point to which the center line of the restriction part **101***b* is projected to a plane that intersects perpendicularly with the center line. A point J**2** is a point to which the center line of the sub-mirror drive shaft **301***b* (the center line of the rotation of the sub-mirror drive member **300***b* to the sub-mirror holder **212***b*) is projected to a plane that intersects perpendicularly with the center line. The three center lines corresponding to the points J**0**, J**1**, and J**2** are approximately parallel mutually, and, accordingly, the points J**0**, J**1**, and J**2** are projected to the same plane that intersects perpendicularly with the three center lines. FIG. **9** shows the mirror unit **200***b* in a state where the points J**0**, J**1**, and J**2** are located on a straight line.

[0056] When the main-mirror drive shaft **205***b* of the main-mirror holder **202***b* in the state in FIG. **8** is driven by the main-mirror drive mechanism (not shown) in the minor-up direction (clockwise in FIG. **8**), the mirror unit **200***b* changes to the minor-up state via the state in FIG. **9**. In the state in FIG. **9**, the connecting sleeve **302***b* contacts the restriction part **101***b* of the mirror box **100***b* because the sub-mirror drive member **300***b* is energized by the sub-minor energization member **400***b*. Since the energization force of the sub-minor energization spring **403***b* is received by the restriction part **101***b* in this state, it does not become a drive load. The sub-mirror holder **212***b* is positioned by the sub-mirror drive member **300***b*, and is driven in the direction to close to the main-mirror holder **202***b* (the direction that decreases the angle between the main-mirror holder **202***b* and the sub-mirror holder **212**) from the state in FIG. **8**.

[0057] In order to reduce the impact that occurs when the main-minor holder **202***b* collides with the minor-up stopper **110***b*, the main-minor drive mechanism applies deceleration control to the rotation of the main-mirror holder **202***b* in the state in FIG. **9**. At this time, since inertia force acts on the sub mirror **211***b*, the sub-minor holder **212***b* tends to rotate in a direction of an arrow R around the sub-mirror rotation hole **213***b*. However, since the points J**0**, J**1**, and J**2** are located on the straight line as shown in FIG. **9**, and since the sub-mirror drive member **300***b* and sub-minor energization member **400***b* are strutted to each other, the motion of the sub-mirror holder **212***b* is restricted. Thereby, when the deceleration control is applied to the main-minor holder **202***b*, decelerating force acts on the sub-mirror holder **212***b* without delay.

[0058] Although the deceleration control is preferably applied to the main-mirror holder **202***b* at the timing when the points J**0**, J**1**, and J**2** are located on the straight line as shown in FIG. **9**, it may be applied at another timing. There is a gap that is required for the angle adjustment of the sub mirror **211***b* between the restriction part **101***b* and connecting sleeve **302***b* as shown in FIG. **7**A. Accordingly, even if the deceleration control is applied to the main-mirror holder **202***b* in a state other than the state in FIG. **9**, the deceleration of the sub-mirror holder **212***b* is not delayed approximately.

[0059] FIG. **10** is a right side view showing the mirror unit **200***b* in the minor-up state. When the main-mirror drive shaft **205***b* of the main-minor holder **202***b* is driven by the main-mirror drive mechanism (not shown) in the mirror-up direction from the state in FIG. **9**, the mirror unit **200***b* changes to the mirror-up state in FIG. **10**. The main-minor holder **202***b* is energized by the main-minor drive mechanism in the minor-up direction and contacts the mirror-up stopper **110***b*. The sub-minor holder **212***b* receives force in a direction of an arrow D**2** from the sub-mirror drive member **300***b* that is pushed up by the sub-mirror energization member **400***b*. The sub-mirror holder **212***b* is energized by the force in the arrow D**2** direction in the minor-up direction around the sub-mirror rotation hole **213***b* and contacts a shock absorber **206***b* provided in the main-minor holder **202***b*. Thus, when the mirror unit **200***b* is in the mirror-up state, the sub-mirror energization member **400***b* energizes the sub mirror **211***b* in the mirror-up direction. At this time, the connecting sleeve **302***b* of the sub-mirror drive member **300***b* is not in contact with the restriction part **101***b* of the mirror box **100***b*.

[0060] A mirror-down action is performed in the inverse order of the above-mentioned mirror-up action. That is, when the main-mirror drive shaft **205***b* of the main-mirror holder **202***b* is driven by the main-mirror drive mechanism in the mirror-down direction from the state in FIG. **10**, the mirror unit **200***b* changes to the state in FIG. **9** and the state in FIG. **8** in order.

[0061] In order to reduce the impact that occurs when the main-mirror holder **202***b* collides with the mirror-up stopper **110***b* and the impact that occurs when the sub mirror **211***b* collides with the sub-minor stopper **112***b*, the main-mirror drive mechanism applies deceleration control to the rotation of the main-mirror holder **202***b* in the state in FIG. **9**. At this time, since inertia force acts on the sub mirror **211***b*, the sub-mirror holder **212***b* tends to rotate in the inverse direction of the arrow R around the sub-mirror rotation hole **213***b*. However, since the mirror unit **200***b* is configured so that the points J**0**, J**1**, and J**2** will be located on the straight line as shown in FIG. **9** and so that the sub-mirror drive member **300***b* and sub-minor energization member **400***b* will be strutted to each other, the motion of the sub-mirror holder **212***b* is restricted. Thereby, when the deceleration control is applied to the main-minor holder **202***b*, the decelerating force acts on the sub-minor holder **212***b* without delay.

[0062] Although the deceleration control is preferably applied to the main-mirror holder **202***b* at the timing when the state in FIG. **9** appears, it may be applied at another timing. There is a gap that is required for the angle adjustment of the sub mirror **211***b* between the restriction part **101***b* and connecting sleeve **302***b* as shown in FIG. **7**A. Accordingly, even if the deceleration control is applied to the main-mirror holder **202***b* in a state other than the state in FIG. **9**, the deceleration of the sub-mirror holder **212***b* is not delayed approximately.

[0063] As mentioned above, since the position of the sub-minor holder **212***b* is settled by the main-mirror holder **202***b* and sub-mirror drive member **300***b*, the sub mirror **211***b* is controllable without delay with respect to the control of the main-minor holder **202***b*. Accordingly, the mirror unit **200***b* lowers the impact that occurs in the sub-mirror holder **212***b* to reduce the mirror bound of the sub mirror **211***b* by controlling the drive of the main-minor holder **202***b* so as to lower the impact that occurs in the main-mirror holder **202***b* to reduce the mirror bound of the main mirror **201***b*.

[0064] Moreover, the sub-mirror holder **212***b* is energized by the sub-mirror energization member **400***b* in the mirror-

down direction when the sub-mirror holder **212***b* is at the mirror-down position and is energized in the mirror-up direction when the sub-mirror holder **212***b* is at the mirror-up position. The energization force of the sub-mirror energization member **400***b* does not become a drive load during the rotation (movement) of the sub-mirror holder **212***b* between the mirror-up position and mirror-down position. Furthermore, since the mirror unit **200***b* is not configured so that the energization force of the sub-mirror energization member **400***b* is once increased and then decreased, its load fluctuation is also small. Such a configuration enables to obtain high driving stability with the simple control to the mirror unit **200***b*.

[0065] Next, the arrangement of the sub-mirror energization member **400***b* will be described. FIG. **11** is a right side view showing the mirror-down state and minor-up state of the mirror unit **200***b* in an overlapped fashion. The points J**0**, J**1**, and J**2** are identical to the points described by referring to FIG. **9**, respectively. A point J**3** is a point to which the center line of the sub-mirror drive shaft **301***b* of the sub-mirror drive member **300***b* is projected to a plane that intersects perpendicularly with the center line. The four center lines corresponding to the points J**0**, J**1**, J**2**, and J**3** are approximately parallel mutually, and accordingly, the points J**0**, J**1**, J**2**, and J**3** are projected to the same plane that intersects perpendicularly with the four center lines.

[0066] When the mirror unit **200***b* is in the mirror-down state, the angle adjustment range of the sub-mirror holder **212***b* to the main-minor holder **202***b* becomes larger as the angle (angle J**0**J**1**J**2**) between the sub-mirror energization member **400***b* and sub-mirror drive member **300***b* is closer to the right angle. On the contrary, when the mirror unit **200***b* is in the mirror-down state, the angle adjustment range of the sub-mirror holder **212***b* to the main-mirror holder **202***b* becomes narrow as the angle (angle J**0**J**1**J**2**) between the sub-mirror energization member **400***b* and sub-mirror drive member **300***b* is closer to 180 degrees.

[0067] Generally, the angle adjustment in the case where the sub-mirror holder **212***b* (sub mirror **211***b*) is in the mirror-down position is needed for guiding light to the focus detection unit **4** with high accuracy. In the meantime, since the mirror-up action is sufficient to retract the sub-minor holder **212***b* from the photographing light path, high accuracy is not needed for the angle of the sub-mirror holder **212***b* (sub mirror or **211***b*) at the mirror-up position. Accordingly, it is preferable that the rotatable range of the sub-mirror holder **212***b* at the mirror-down position be larger than the rotatable range at the minor-up position.

[0068] In order to achieve such a configuration, it is preferable that the angle (angle J**0**J**1**J**2**) between the sub-mirror energization member **400***b* and sub-mirror drive member **300***b* be close to the right angle when the mirror unit **200***b* is in the mirror-down state. In other words, it is preferable that the supporting hole **401***b* (point J**0**) of the sub-minor energization member **400***b* in the mirror-down state be arranged nearer to the sub-minor drive member **300***b* than a median line (a broken line L in FIG. **11**) of a rotatable angle (angle J**2**J**1**J**3**) of the sub-minor drive member **300***b*.

[0069] Although the preferable embodiments of the present invention have been described above, the present invention is not limited to these embodiments, and various deformations and variations are available within the scope of the present invention. For example, the rotatable range of the sub-minor energization member **400***b* is restricted by the backlash between the connecting sleeve **302***b* of the sub-minor drive member **300***b* and the restriction part **101***b* of the mirror box **100***b*. A configuration that directly restricts the sub-minor energization member **400***b* may be provided in the mirror box **100***b* instead. This improves durability because the sliding parts, such as the connecting sleeve **302***b* and restriction part **101***b*, that slide during driving of the mirror unit **200***b* are eliminated.

Other Embodiments

[0070] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0071] This application claims the benefit of Japanese Patent Application No. 2018-200948, filed Oct. 25, 2018, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A mirror drive device comprising:

a first holding member that holds a first mirror;

a supporting member that rotatably supports the first holding member;

a second holding member that holds a second mirror and is rotatably supported by the first holding member; and

a drive member that is rotatably supported by the supporting member and is rotatably connected with the second holding member,

wherein rotation of one of the first holding member and the second holding member interlocks with rotation of the other through rotation of the drive member.

2. The mirror drive device according to claim **1**, wherein a position of a rotation center of the drive member to the supporting member is adjustable on a circular arc around a rotation axis of the first holding member.

3. A mirror drive device comprising:

a first holding member that holds a first mirror;

a supporting member that rotatably supports the first holding member;

a second holding member that holds a second mirror and is rotatably supported by the first holding member;

an energization member that is rotatably supported by the support member;

a drive member that is rotatably connected to the energization member and is rotatably connected with the second holding member; and

a restriction part that is provided in the support member and restricts a rotatable range of the energization member,

wherein the energization member is energized in one of two rotatable directions, and

wherein rotation of one of the first holding member and the second holding member interlocks with rotation of the other through rotation of the drive member.

4. The mirror drive device according to claim **3**, wherein the restriction part is a shaft,

wherein the drive member has a first cylindrical portion in which the shaft is inserted,

wherein the energization member has a second cylindrical portion that fits to an outer periphery of the first cylindrical portion,

wherein a predetermined gap is provided between an outer periphery of the shaft and an inner periphery of the first cylindrical portion, and

wherein the energization member is rotatable within a range of the predetermined gap.

5. The mirror drive device according to claim **4**, wherein a center line of rotation of the energization member, a center line of the shaft, and a center line of rotation of the second holding member are approximately parallel mutually,

wherein three points to which the center lines are projected to a plane that approximately intersects perpendicularly with the center lines are located on a straight line during rotation of the first mirror between a first position in a photographing light path and a second position outside the photographing light path.

6. The mirror drive device according to claim **5**, further comprising a drive mechanism that rotates the first holding member between the first position and the second position,

wherein the drive mechanism applies deceleration control to rotation of the first holding member in a state where the three points are located on the straight line.

7. The mirror drive device according to claim **5**, wherein a rotation center of the energization member in a state where the first holding member is in the first position is arranged nearer to the drive member than a median line of a rotatable angle of the drive member during the rotation of the first holding member between the first position and the second position.

8. An image pickup apparatus comprising:

a focus detection sensor;

an optical finder;

a mirror unit that is provided with a first mirror that reflects a light beam entered through a photographing optical system to the optical finder and a second mirror that reflects a light beam transmitted through the first mirror toward the focus detection sensor; and

a mirror drive device comprising:

a first holding member that holds the first mirror;

a supporting member that rotatably supports the first holding member;

a second holding member that holds the second mirror and is rotatably supported by the first holding member; and

a drive member that is rotatably supported by the supporting member and is rotatably connected with the second holding member,

wherein rotation of one of the first holding member and the second holding member interlocks with rotation of the other through rotation of the drive member.

9. An image pickup apparatus comprising:

a focus detection sensor;

an optical finder;

a mirror unit that is provided with a first mirror that reflects a light beam entered through a photographing optical system to the optical finder and a second mirror that reflects a light beam transmitted through the first mirror toward the focus detection sensor; and

a mirror drive device comprising:

a first holding member that holds the first mirror;

a supporting member that rotatably supports the first holding member:

a second holding member that holds the second mirror and is rotatably supported by the first holding member;

an energization member that is rotatably supported by the support member;

a drive member that is rotatably connected to the energization member and is rotatably connected with the second holding member; and

a restriction part that is provided in the support member and restricts a rotatable range of the energization member,

wherein the energization member is energized in one of two rotatable directions, and

wherein rotation of one of the first holding member and the second holding member interlocks with rotation of the other through rotation of the drive member.

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